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(54) Gripper & wrist joint for a robotic arm.

(57) A gripper and wrist joint assembly for a robotic arm is disclosed. The gripper comprises a pair of identical jaws (12) connected by a pivot (14) and including V-sections (34) for holding large objects and end-mounted pivotal tips (20) for holding small and flat sided objects. The jaws are opened and closed by rotation of a screw-threaded rod (40) having screw threaded connections with the jaws, the axis of the rod (40) being fixed and the pivot pin (14) being guided for linear displacement during adjustment of the jaws so that they are maintained central within the gripper housing (36).

The wrist includes a pair of spiroid bevel gears (68, 69) driven by respective spiroid pinions (70, 71) and each meshing with an output bevel gear (76) carried on a shaft (77) equipped with an adjustment nut for urging the bevel gears (68, 69, 76) into firm engagement and enabling backlash to be eliminated.

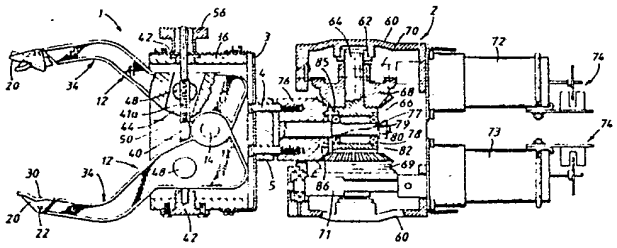

FIG.2.

EP 0 355 866 A2

Gripper and Wrist Joint for a Robotic Arm

This invention relates to a gripper for a robotic arm and to a wrist joint for a robotic arm. The aims of the invention are to provide a gripper and a wrist joint which facilitate accurate control by microprocessor.

According to the present invention there is provided a wrist joint for a robotic arm, comprising first and second bevel gears journalled in a housing for rotation about a given axis, respective drive mechanisms for rotating the first and second bevel gears, and an output bevel gear meshing with the first and second bevel gears and carried on a shaft having an axis perpendicular to said given axis, characterised in that the first and second bevel gears are combined gears, the drive mechanism for each of the first and second gears comprises a driving pinion meshing therewith, and an adjustment means is coupled to the shaft and is adjustable relative to the shaft to urge the output gear into firm meshing engagement with the first and second gears and thereby to urge the first and second gears into firm meshing engagement with the driving pinions.

The adjustment means facilitates assembly of the wrist joint by enabling backlash to be conveniently eliminated, which in turn permits accurate control of the wrist joint. In a preferred construction the adjustment means comprises a nut having screw threaded connection on the shaft. The nut can be arranged to cooperate with abutment means on a bearing housing accommodating a bearing for the shaft.

A gripper and wrist joint assembly embodying the invention will now be described in more detail, with reference being made to the accompanying drawings in which:-

Figure 1 is a top plan view of the assembly, but with the gripper jaws not shown;

Figure 2 is a section through the assembly;

Figure 3 is a rear end view of the assembly;

Figure 4 is a side view of the assembly;

Figure 5 is a front elevation of the gripper with the jaws removed;

According to the present invention there is provided a wrist joint for a robotic arm, comprising first and second bevel gears journalled in a housing for rotattion about a given axis, respective drive mechanisms for rotating the first and second bevel gears, and an output bevel gear meshing with the first and second bevel gears and carried on a shaft having an axis perpendicular to said given axis, characterised in that the first and second bevel gears are combined gears, the drive mechanism for each of the first and second gears comprises a driving pinion meshing therewith, and an adjustment means is coupled to the shaft and is adjustable relative to the shaft to urge the output gear into firm meshing engagement with the first and second gears and thereby to urge the first and second gears into firm meshing engagement with the driving pinions.

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A gripper and wrist joint assembly embodying the invention will now be described in more detail, with reference being made to the accompanying drawings in which:-

Figure 1 is a top plan view of the assembly, but with the gripper jaws not shown;

Figure 2 is a section through the assembly;

Figure 3 is a rear end view of the assembly;

Figure 4 is a side view of the assembly;

Figure 5 is a front elevation of the gripper with the jaws removed;

Figure 6 is a top view of a gripper jaw;

Figure 7 is an underneath view of the gripper jaw;

Figure 8 is a front end view of the gripper jaw;

Figure 9 is a side view of the gripper jaw as seen in the direction of arrow A in Figure 6;

Figure 10 is a section along the line X-X in Figure 6;

Figure 11 is a front perspective view showing a gripper tip mounted on a gripper jaw;

Figure 12 is a rear perspective view of the gripper tip; and

Figures 13a to 13e illustrate the gripper holding objects of different shapes and sizes.

The gripper and wrist joint assembly shown in Figs. 1 to 4 may be mounted at the end of a robotic arm, a spigot 10 being shown attached to the wrist housing for this purpose. The gripper and wrist joint are separate sub-assemblies and each could be used without the other. As shown the gripper 1 is attached to wrist joint 2 by a bracket 3 and screws 4, a spacer 5 being shown interposed between the bracket and the output member of the wrist joint.

The gripper has a pair of identical moulded jaws 12, each being as shown in Figs. 6-10. The jaws are pivoted together by a pin 14 which extends through aligned holes 16 formed in the jaws

at their rear or inner ends. Each jaw has a forked forward end defining projections 18 on which a gripping tip 20 is mounted for limited angular movement about the axis of a pivot pin 22 which extends through a pair of ears 24 provided on the back of the tip and through the projections 18 which are received between the ears (see Figs. 11 and 12). A coil torsion 26 spring is located on the pin 22 and urges the tip with a light spring force to a limit position defined by abutment faces 28 on the projections 18. Movement of the tip in the opposite direction is limited by abutment with the shoulder 29 on the jaw at the root of the projections 18. The two extreme positions are shown in Figure 2 for the tip of the upper jaw in that figure. The tip 20 has a planar gripping face with perpendicular V-notches 30, 32 extending across it parallel and perpendicular to the pivot pin 22 respectively.

Adjacent its forward end the jaw 12 includes a V-like section 34, the vertex of the V having an obtuse angle and being rounded. These V-sections of the two jaws can be used to grasp and hold relatively large objects, such as a cylindrical article as shown in Figure 13a. The tips 20 enable objects of other shapes and sizes to be held. Thus, the notches 32 of the tips allow small cylinders to be held in the plane of the gripper as shown in Fig. 13b, and the notches 30 enable a small cylindrical object to be held normal to the plane of the gripper as shown in Fig. 13c. It should be noted that the notches 30 are displaced forwardly with respect to the pivot pins 22 so that, when used to grasp an object as in Fig. 13c, the reaction forces maintain the tips 20 in firm engagement against the abutment faces 28 on the jaw projections. The planar gripping faces of the tips 20 are used for holding both large and small flat sided objects, e.g. as shown in Figs 13d and 13e. When the tips 20 are closed against a generally parallel-sided object, as in Figs. 13b and 13d, the rear ends of the tips contact the object first and as the jaws continue to close the tips are pivoted against the bias of the springs 26 until the front ends of the tips engage the object also. From the foregoing it will be understood that the gripper of the invention is able to hold securely objects of widely differing shapes and dimensions by simple pivotal actuation of the gripper jaws.

The rear ends of the gripper jaws are received in a housing 36 and adjusting means are provided for pivoting the jaws relative to each other about the axis of the pivot pin 14. The adjusting means includes a screw threaded rod 40 journalled in the housing by bushes 42 for rotation about a fixed axis. The jaws have transverse through openings 44 of rectangular cross-section, and circular apertures 46 which intersect with the openings and receive cylindrical bushes 48, the rod 40 passing through the openings 44 and through internally threaded holes in the bushes 48. The bushes 48 and the respective threaded sections 41a, 41b of rod 40 cooperating therewith are oppositely threaded, whereby rotation of the rod in one direction causes the jaws 12 to be closed together and rotation of the rod in the opposite direction causes them to be opened apart. The ends of the pivot pin 14 projects from the jaws 12 and engages slidably in slots 50 provided on the inside of the top and bottom walls of the housing. The slots guide the pivot pin 14 for linear displacement during adjustment of jaws thereby ensuring that the jaws remain central in the gripper housing and are always symmetrical with respect to a plane containing the pivot axis. As a result both initial assembly of the gripper and accurate positional control of the gripper of the end of a manipulator arm are facilitated.

An electric motor 52 is mounted on the gripper housing and is operable to rotate the adjusting rod through gears 54, 56. In Figures 1 to 4 an encoder device 58 is shown connected to the motor 52 to enable the speed and position of the gripper jaws to be controlled by a microprocessor.

The wrist joint 2 has a two-part housing 60 including opposed bosses which receive sleeve bearings 62 for the free ends of shafts 64 extending in opposite directions from a central bearing housing 66. Rotatable on the respective shafts 64 are first and second combined spiroid and bevel gears 68, 69 which mesh with respective spiroid driving pinions 70, 71 journalled for rotation in the respective housing parts and connected to respective driving motors 72, 73 which are equipped with encoder devices 74 for microprocessor control. The combined spiroid and bevel gears mesh with an output bevel gear 76 carried on a shaft 77 journalled in the housing 66 by bearings 78, 79. The end of the shaft 77 projecting through the housing 66 is threaded and carries a nut 80 which presses the bearing 78 against an abutment defined on the housing 66 by a circlip 82.

During assembly of the wrist joint the nut 80 is tightened to draw the shaft 77 and hence the output bevel gear 76 into firm mesh with the spiroid bevel gears 68,69. The side thrust thus generated on the spiroid bevel gears forces them into hard mesh with the spiroid pinions and since the cross shaft 64 can float axially in bearings 62 an equal meshing force between both sets of spiroid pinions is maintained. Backlash can thus be controlled on all four meshing surfaces by a single adjustment of nut 80. Shims may be introduced between the housing halves which are secured by screws 84 (Figure 1) to ensure ideal meshing between the bevel gears on assembly.

The thrust of the output bevel 76 is transmitted

to the housing through the bearing 78, circlip 82,bearing housing 66 and shafts 64.

In use of the wrist joint, operating the drive motors 72, 73 at the same speed and in the same direction results in the gripper 1 pitching without rolling, i.e. the output bevel gear 76 is turned around the axis of the shafts 64 without being rotated about its own axis. Operation of the motors at the same speed but in opposite directions results in rolling motion only, the output gear 76 only rotating about the axis of its shaft 77. Any other combination of motor speeds and directions produce a combined pitch and roll movement of the gripper 1.

It will be seen that a stop pin 85 fitted to the end of bearing housing 66 projects into a slot in the rear face of gear 76 and engages a stop pin 86 positioned in the slot to limit the rolling movement. Pitching movement is limited by the output gear 76 engaging the housing 60 at the end of its travel about the axis of shafts 64.

The mounting spigot 10 can define a jaw axis for the gripper and wrist assembly, the axis of this spigot being coincident with axes of pitch and roll motions whereby control is facilitated.

From Figure 2 of the drawings it can be seen that the spiroid pinions 70, 71 mesh with the respective spiroid gears 68, 69 at opposite sides. This enables the use of identical spiroid gears 68, 69 which is an advantage.

The gripper described in this specification is claimed in European application 86901472.0.

Claims

1. A wrist joint for a robotic arm, comprising first and second bevel gears (68, 69) journalled in a housing (60) for rotation about a given axis, respective drive mechanisms (70, 72 and 71, 73) rotating the first and second bevel gears, and an output bevel gear (76) meshing with the first and second bevel gears and carried on a shaft (77) having an axis perpendicular to said given axis,
characterised in that the first and second bevel gears are combined gears (68, 69), the drive mechanism for each of the first and second gears comprises a driving pinion (70, 71) meshing therewith, and an adjustment means (80) is coupled to the shaft (77) and is adjustable relative to the shaft to urge the output gear (76) into firm meshing engagement with the first and second gears and thereby to urge the first and second gears into firm meshing engagement with the driving pinions.

2. A wrist joint according to claim 1, wherein an end of the shaft (77) is screw-threaded and the adjustment means comprises a nut (80) screwed onto the shaft.

3. A wrist joint according to claim 2, wherein the shaft (77) is journalled for rotation in a bearing housing (66), the end of the shaft projecting through the bearing housing carrying the adjustment nut, and the bearing housing being provided with an abutment (82) against which the thrust forces of the output gear (76) are transmitted by the adjustment nut (80).

4. A wrist joint according to claim 1, 2 or 3, wherein the first and second gears are combined spiroid and bevel gears (68, 69), and the drawing pinions are spiroid pinions (70, 71).

5. A wrist joint according to claim 4 wherein the first and second combined spiroid and bevel gears are substantially identical to each other.

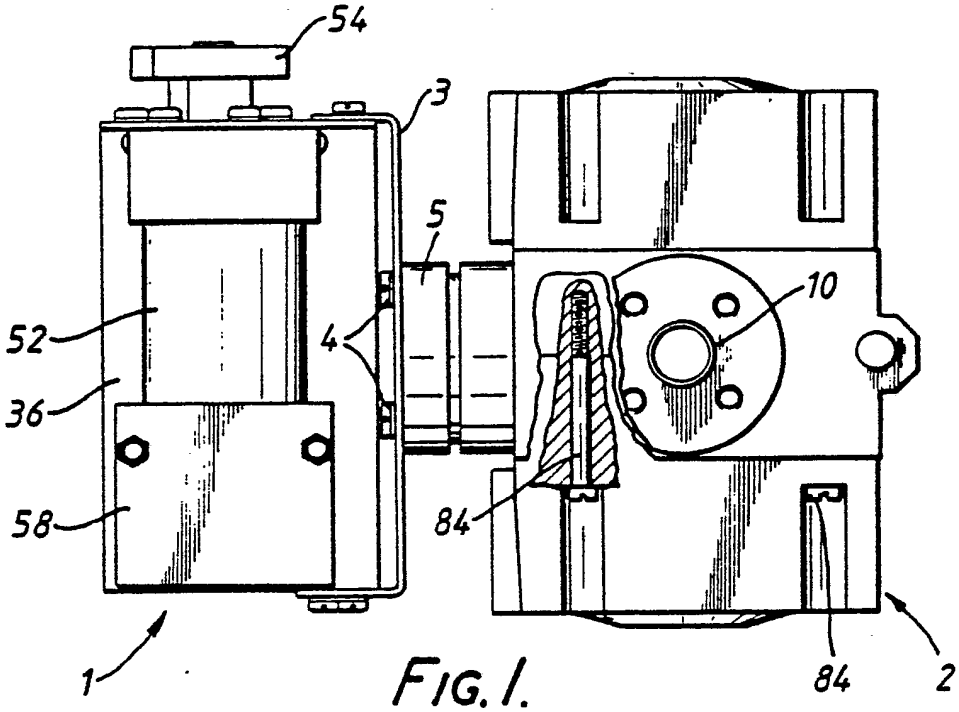

FIG. 1.

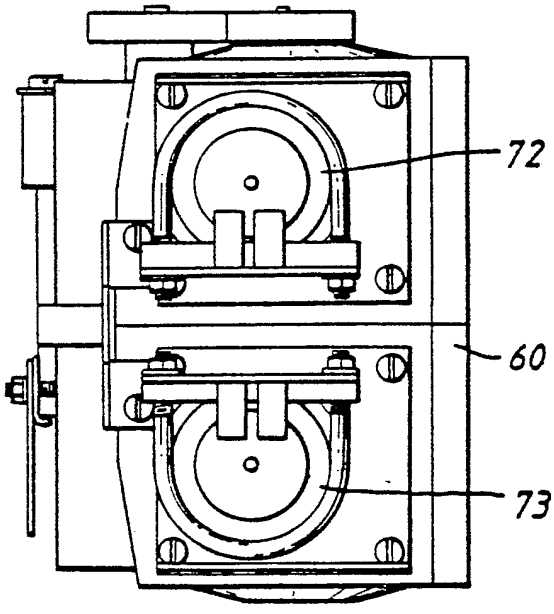

FIG. 3.

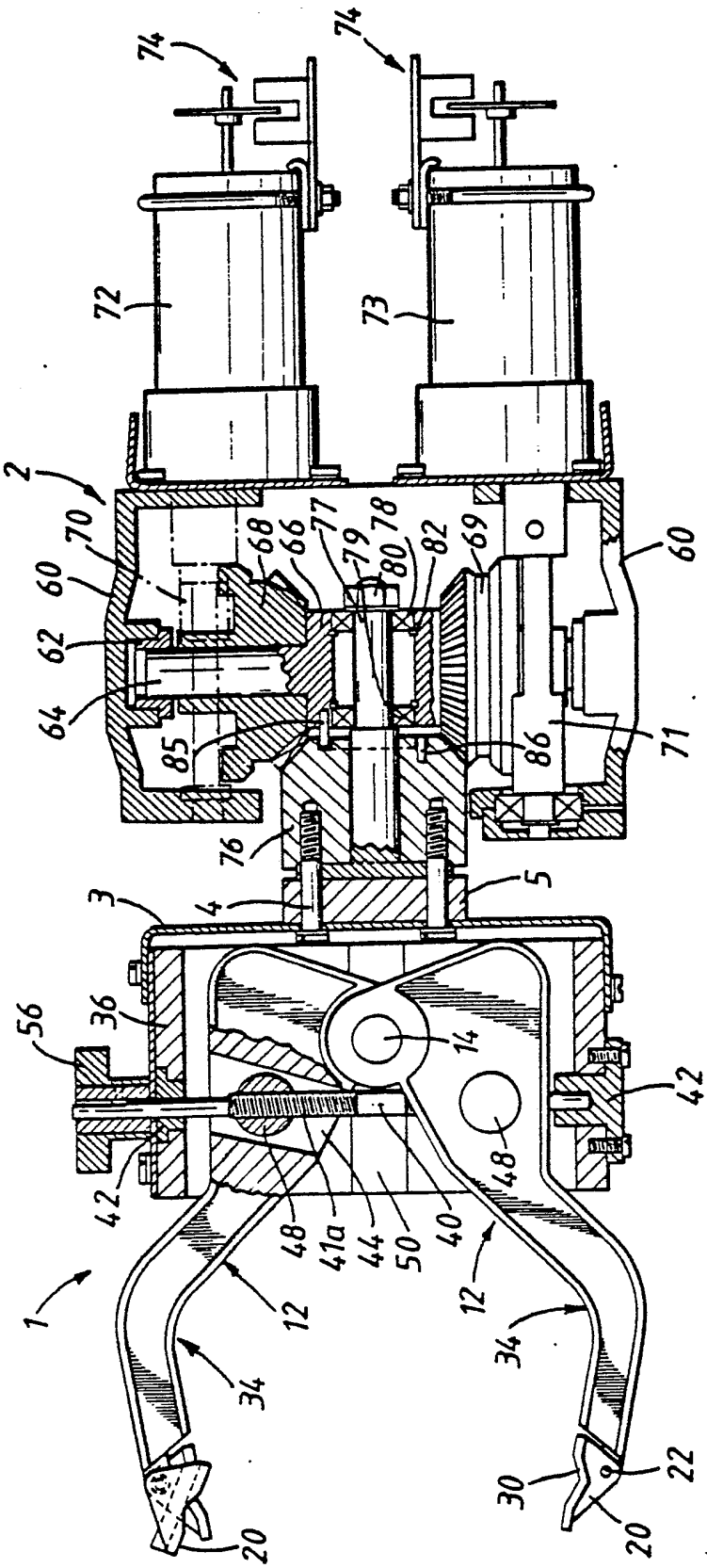
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FIG.2.

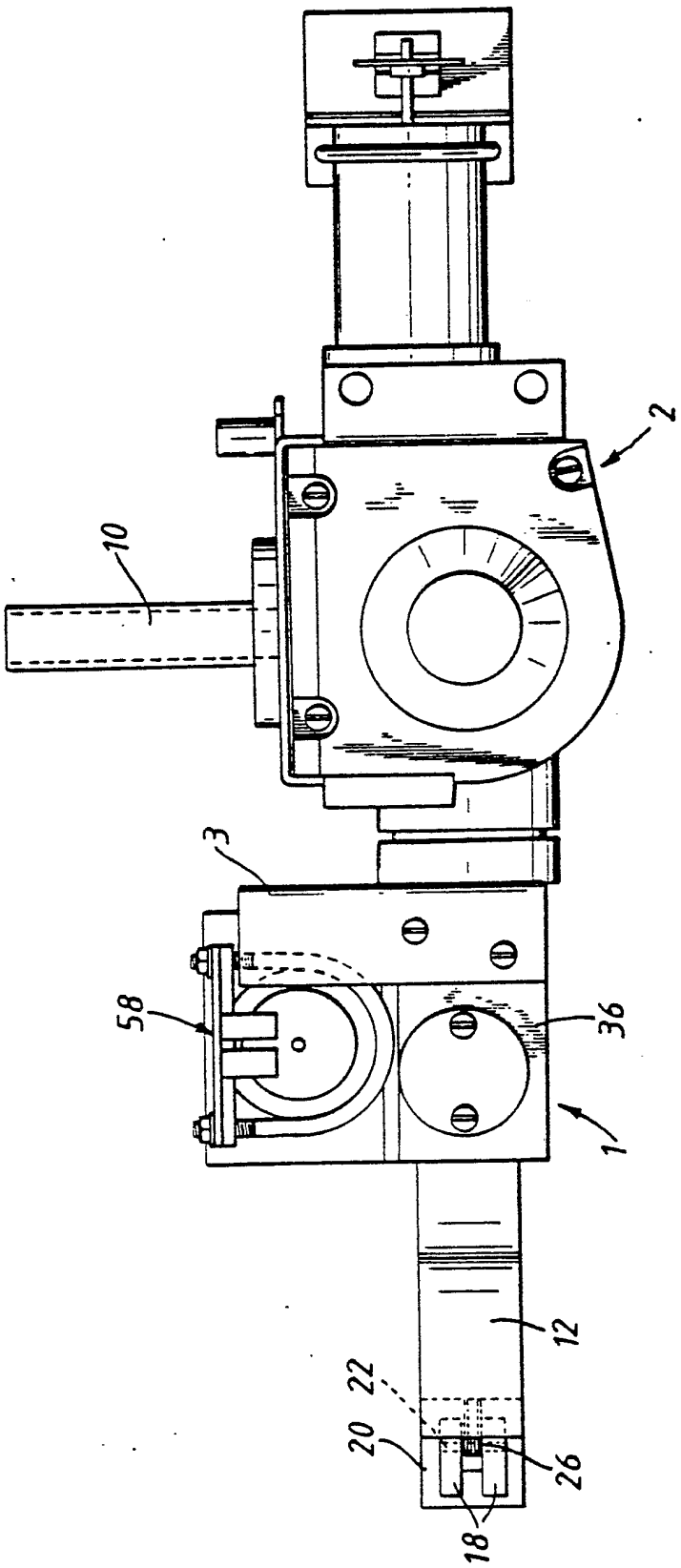

FIG. 4.

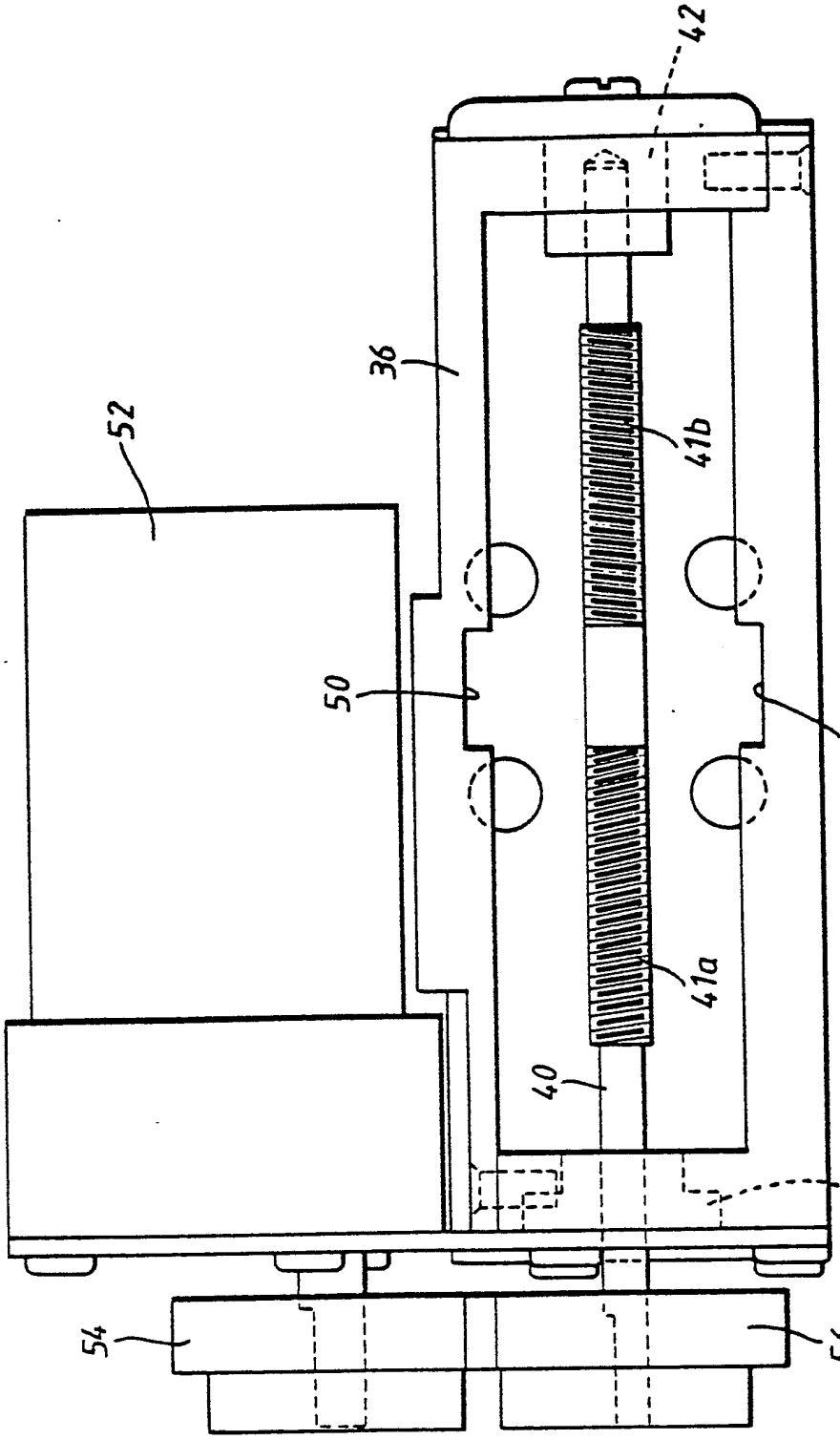

FIG. 5.

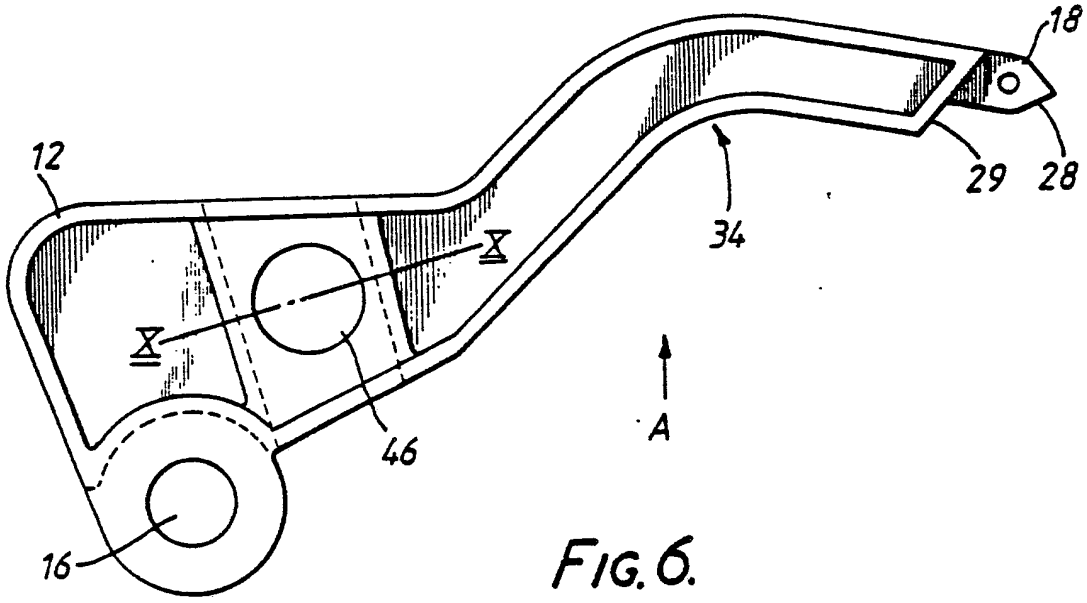

FIG. 6.

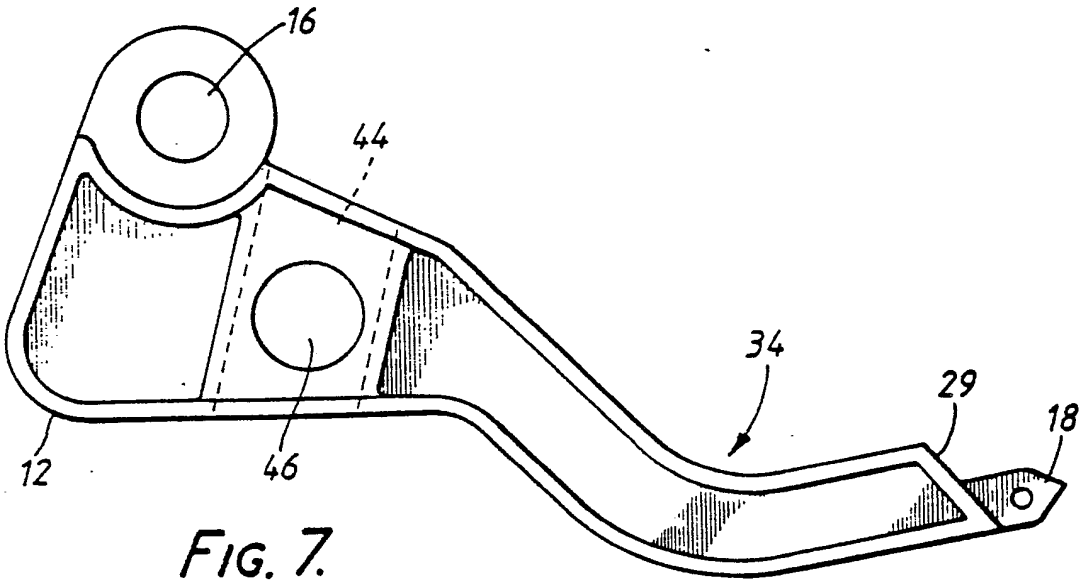

FIG. 7.

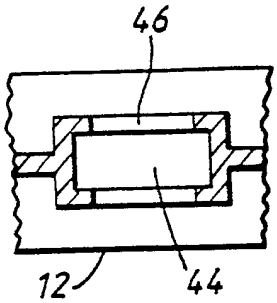

FIG. 10.

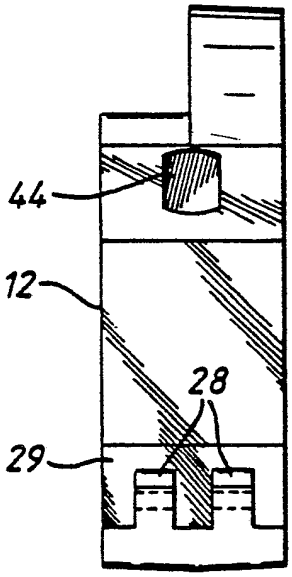

FIG. 8.

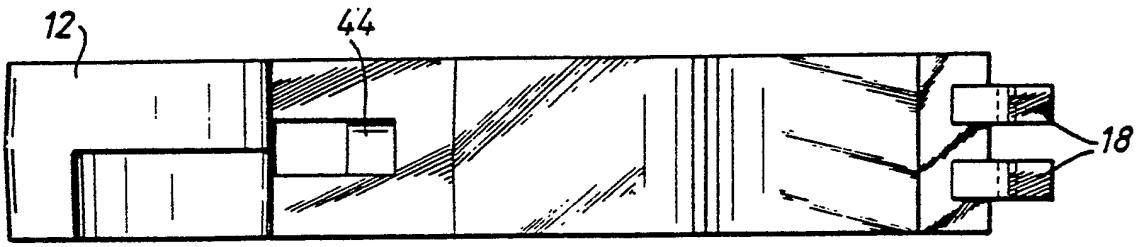

FIG. 9.

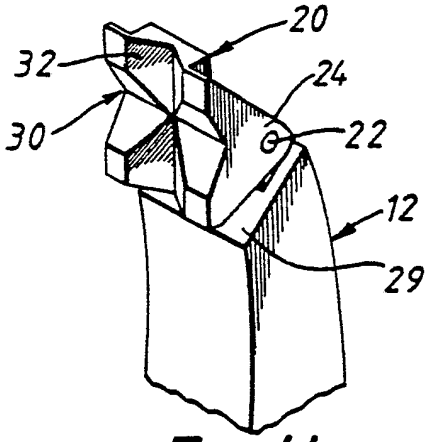

FIG. 11.

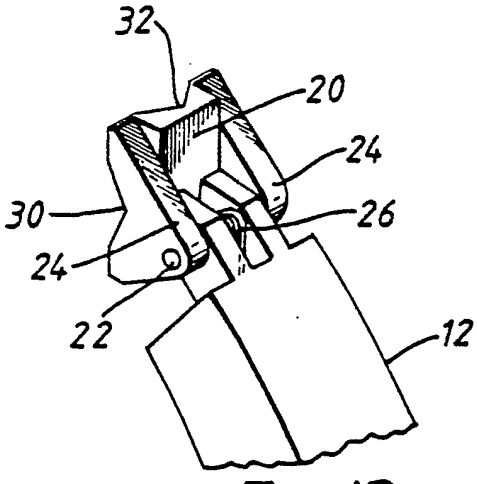

FIG. 12.

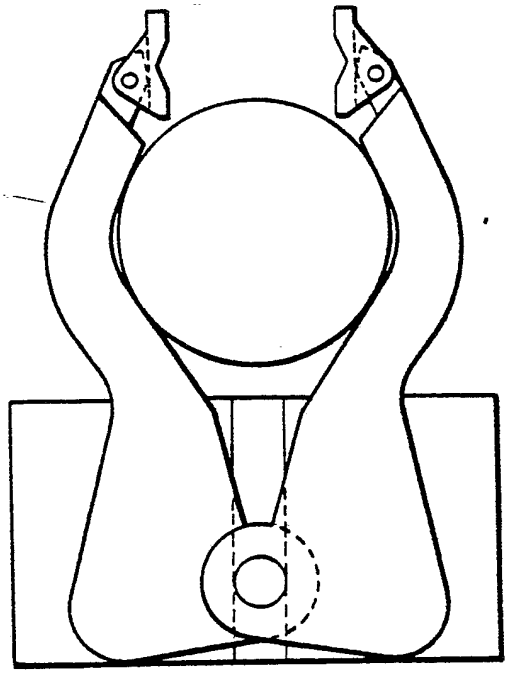

FIG. 13a.

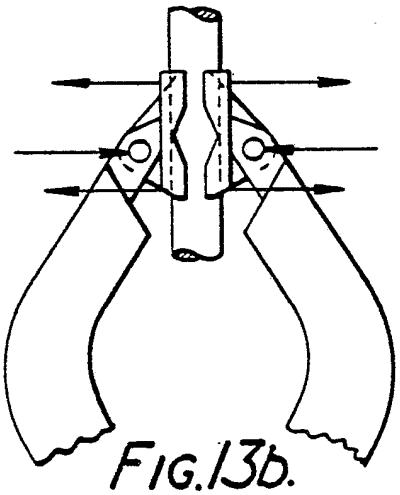

FIG. 13b.

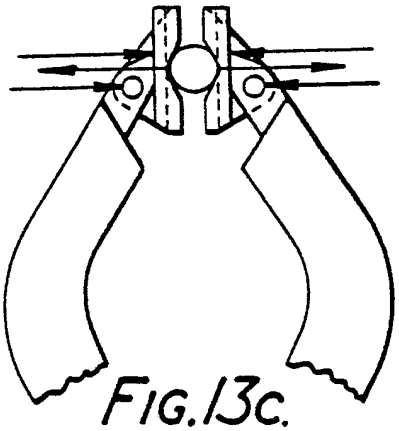

FIG. 13c.

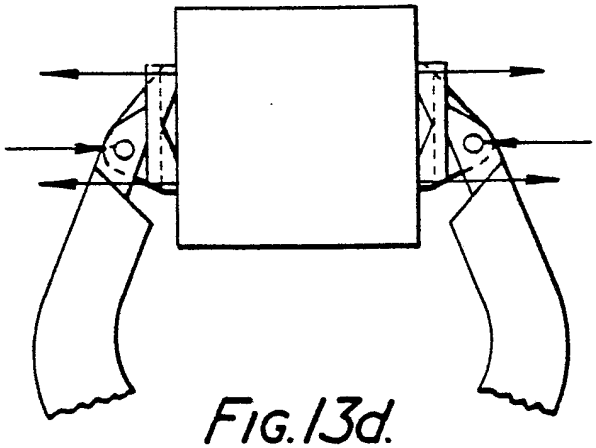

FIG. 13d.

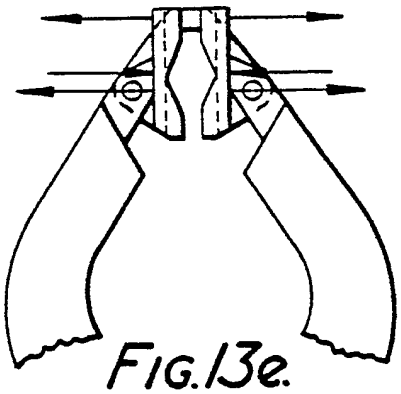

FIG. 13e.

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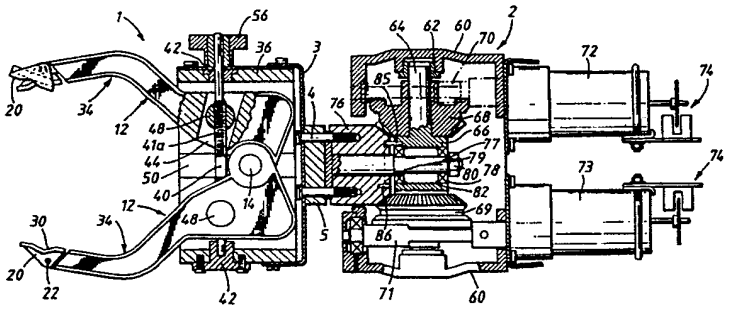

FIG.2

EP 0 355 866 A3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 89 11 8422

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	AU-A-3090684 (EX-CELL-O CORPORATION) * page 5, lines 13 - 30; figures 1-3 *	1, 2, 4, 5	B25J17/02 B25J9/10 B25J15/02
Y	EP-A-0101569 (GESELLSCHAFT FUR DIGITALE AUTOMATION MBH) * page 4, lines 19 - 31 *	1-3	
A		4, 5	
Y	EP-A-0089129 (FANUC LTD) * claims 1, 3 *	1-3	
P,X	EP-A-0157980 (K.K.TOSHIBA) * page 5, line 32 - page 6, line 20; figure 1b *	1, 2	
P,Y	GB-A-2157649 (CGA CORP.) * page 2, lines 65 - 89; claim 6 *	1, 4, 5	
Y	EP-A-0078113 (U.K.A.E.A.) * page 20, line 19 - page 21, line 5 *	1, 4, 5	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B25J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	18 MAY 1990	LAMMINEUR P.C.G.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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E : earlier patent document, but published on, or after the filing date
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